DIVISION OF ENVIRONMENT
QUALITY MANAGEMENT PLAN

PART III:

GROUNDWATER QUALITY MONITORING PROGRAM
QUALITY ASSURANCE MANAGEMENT PLAN

Kansas Department of Health and Environment
Division of Environment
Bureau of Environmental Field Services
Technical Services Section
Building 283, Forbes Field
Topeka, Kansas 66620

SIGNATURES AND APPROVALS

Name: Bryan Bain
Title: Manager, Groundwater Quality Monitoring Program

Signature_______________________________________ Date______________________________

Name: Anthony Stahl
Title: Chief, Stream and Groundwater Chemistry Unit

Signature_______________________________________ Date______________________________

Name: Robert Angelo
Title: Chief, Technical Services Section

Signature_______________________________________ Date______________________________

Name: Robert Angelo
Title: Bureau Quality Assurance Representative

Signature_______________________________________ Date______________________________

TABLE OF CONTENTS

Section 1

INTRODUCTION

1.1 Purpose of Document

This document presents the quality assurance (QA) management plan for the Kansas groundwater quality monitoring program. Quality assurance goals, expectations, organizational responsibilities, and program evaluation and reporting requirements are specifically addressed. Standard operating procedures (SOPs) for collection, preservation, transport and analysis of groundwater samples are provided in the appendices.

1.2 Historical Background

Public concern about the widespread degradation of the nation's surface water and groundwater resources eventually led to the enactment of the Federal Water Pollution Control Act amendments of 1972 (i.e., the Clean Water Act) and the 1974 Safe Drinking Water Act. In Kansas, this concern also resulted in the establishment, in 1976, of a cooperative groundwater monitoring program between the United States Geological Survey (USGS) and the Kansas Department of Health and Environment (KDHE). Sample collection and data interpretation under this program were conducted by the USGS while all laboratory analyses of groundwater samples were performed by KDHE. The program's initial objectives were to describe water quality characteristics of the principal aquifers in the state, identify areas of potential pollution concern, and evaluate the data with respect to state and federal water quality criteria.

The sampling network was originally comprised of approximately 500 water wells utilized for public water supply, rural/domestic water supply, irrigation, and/or livestock watering. About 40 wells were sampled the first year, and from 250 to more than 500 wells were sampled each year for the next five years. In all, over 750 different wells were sampled during the period 1976-1981. In 1982, the sampling network was reduced to 250 annually sampled wells due to budget constraints. Most of the sites eliminated from the network were wells yielding less than 10 gallons per minute (GPM). The program gradually began to focus on regional groundwater quality characteristics and the detection of possible changes and long-term trends in groundwater chemistry.

In 1990, KDHE assumed all operational and managerial aspects of the Kansas groundwater quality monitoring program. Although the basic sampling network was left intact, several improvements were made. Legal descriptions were double-checked for all network sites, and wells were tagged with a unique site identification (SID) number and photographed to reduce the risk of sampling the wrong well in the future. Also, the Kansas Water Database, the electronic repository of the groundwater quality data, was updated to reflect changes and corrections to the list of monitoring well locations.

In 1991 resource constraints required that sampling frequency be reduced at all sites. This entailed a change to a two-year rotational sampling schedule, in which one-half the network was sampled each year. In 1992, work began to precisely describe the location of each monitoring site via the global positioning system (GPS). This system involves use of a portable satellite receiver which accurately determines and records latitude and longitude at any given point (Appendix B). Due to growing interest and concern, the frequency of pesticide sample collection was doubled at all monitoring wells in 1993. Radon also was added to the list of analyzed constituents at this time.

In 1998, the monitoring network underwent a thorough review and reorganization. No sample collection or field work was conducted during the calendar year for this reason. A decision was made to report on the program's findings primarily on an aquifer-by-aquifer basis using an aquifer map for the state adapted from a similar map produced in digital format by the Kansas Geological Survey (KGS) and USGS. Sixty-five wells were dropped from the network following a determination that they did not represent one of the state's five major aquifer systems. Twenty-four upgradient (background) monitoring wells from other KDHE regulatory programs were added to enhance the network's coverage of the major aquifers. These changes lead to the current distribution of monitoring wells depicted in Figure 1.2-1, below. The network now includes a maximum of 200 wells used for public water supply, rural/domestic water supply, irrigation, livestock watering, industrial water supply, groundwater monitoring, or a combination of these uses.

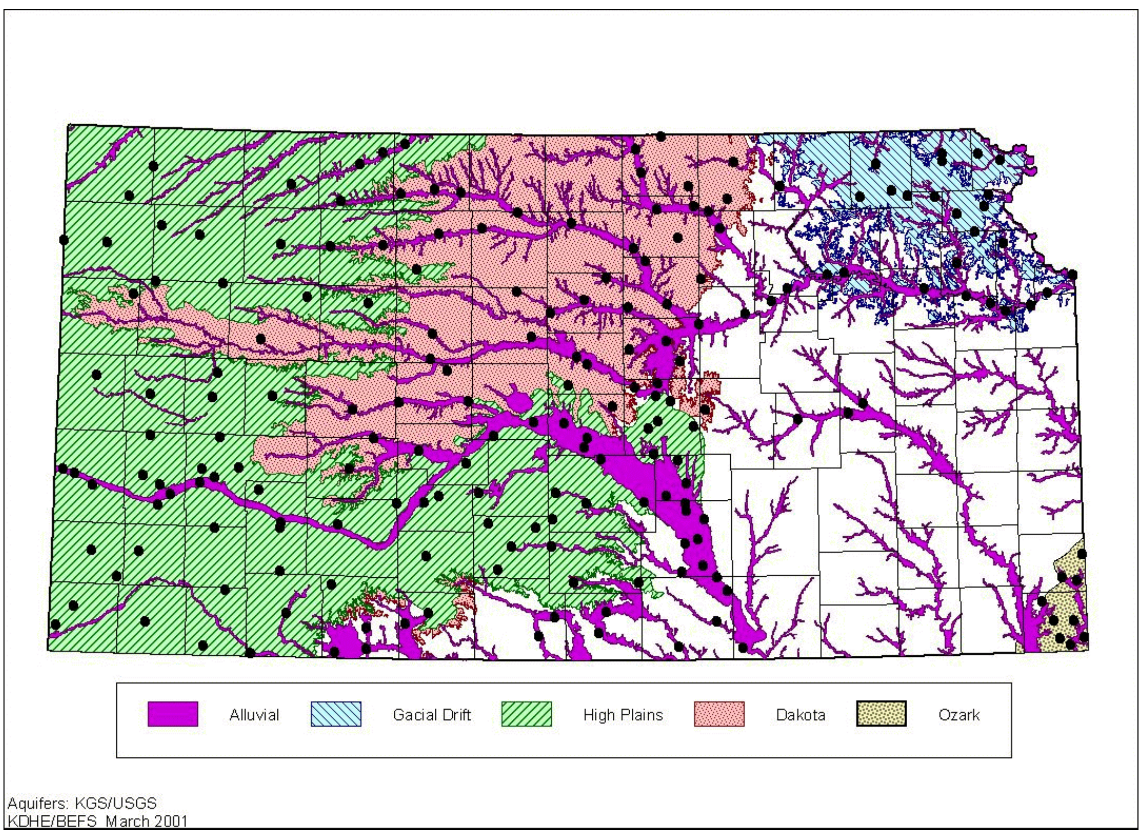

Figure 1.2-1. Map depicting major aquifer systems in Kansas and location of all wells currently included in BEFS groundwater quality monitoring network.

Occasionally, wells are dropped from the network due to abandonment or other reasons and replaced by new wells. All wells continue to be sampled on a two-year rotational schedule. A maximum total of 100 inorganic chemistry, 100 pesticide, 25 volatile organic compound (VOC), and 25 radionuclide (plus 10 radon) samples are collected and analyzed each year (sections 4.2 and 4.4). The VOC and radiological samples are collected on an eight year rotational schedule. Data collected through the Kansas groundwater quality monitoring program are periodically reviewed and analyzed by the program manager and entered in the Kansas Water Database and the United States Environmental Protection Agency (EPA) STORET Database (section 4.8). A comprehensive program report is scheduled for preparation and publication at the conclusion of each six year reporting period (section 4.11).

1.3 Program Objectives

The primary objective of this monitoring program is to provide reliable information on groundwater quality for use in the identification of any temporal and spatial trends in aquifer chemistry associated with (1) alterations in land use patterns, (2) advances in land treatment methods and other resource management practices, (3) changes in groundwater availability or withdrawal rates, and (4) variations in regional climatological conditions. Information derived from this program also supports agency efforts to identify groundwater contamination sites and develop scientifically defensible environmental standards, wastewater treatment plant permits, and groundwater remediation plans.

Section 2

QUALITY ASSURANCE GOALS AND EXPECTATIONS

The foremost goal of this QA management plan is to ensure that the groundwater quality monitoring program produces data of known and acceptable quality. "Known quality" means that the precision, accuracy, completeness, comparability and overall representativeness of the data are documented to the fullest practicable extent. "Acceptable" means that the data support, in a scientifically defensible manner, the informational needs and regulatory functions of the Bureau of Environmental Field Services (BEFS), the Division of Environment, and the agency. The success of the program in meeting this general goal is judged on the basis of the following data performance criteria and requirements:

(1) Where practicable, the reliability of program data shall be documented in a quantitative fashion. For routine water chemistry parameters, the precision of data shall be evaluated through the use of field duplicate samples and the accuracy of data shall be evaluated through the use of field blanks and spiked samples. The average coefficient of variation among duplicate samples shall, for all parameters, be less than twenty percent; spike recoveries shall average between 80 and 120 percent of the actual spike concentrations; background contaminant levels (determined through the analysis of field blanks) shall constitute, on average, less than ten percent of the reported sample concentrations.

(2) Loss of physicochemical data due to sample collection, transport or analytical problems, or to the subsequent mishandling of data, shall be limited to less than five percent of the data originally scheduled for generation. Where problems occur and a substantial quantity of data is lost, an effort shall be made to resample the effected well(s) to maximize data completeness.

(3) Changes in the methods used to obtain and analyze groundwater quality samples shall be carefully documented through formal revisions to the standard operating procedures (SOPs) appended to this QA management plan. This requirement is intended to help maintain a reasonably consistent database over time, enhance knowledge of the effects of any procedural changes on reported contaminant concentrations, and facilitate the identification and evaluation of long-term trends in groundwater quality.

(4) Data generated through this program shall be compared and contrasted with other available monitoring data to examine the representativeness of program findings relative to other reported results. Staff shall attempt to ascertain the probable causes of any discrepancies observed between the various existing databases and describe, in end-of-year program reports, the magnitude and practical significance of such discrepancies.

Section 3

QUALITY ASSURANCE ORGANIZATION

3.1 Administrative Organization

The groundwater quality monitoring program is one of several statewide environmental monitoring programs administered by the Technical Services Section, Bureau of Environmental Field Services (see DOE Quality Management Plan, Part II, BEFS QA Management Plan). Program offices are located at Forbes Field in Topeka, Kansas.

3.2 Staff Responsibilities

Program staff include one environmental scientist II, affiliated with the BEFS Technical Services Section. This individual serves as the program manager, conducts most program planning, data interpretation, and report writing activities, monitors program QC, appraises the unit and section chiefs of any equipment needs or staff training needs, and participates in the annual review and revision of the program QA management plan (see section 5). Other duties include the routine maintenance of field equipment, the scheduling of laboratory services, and the review and verification of laboratory data prior to transfer to the Kansas Water Database and EPA STORET database (section 4.8). Personnel from other BEFS programs may occasionally participate in program operations for cross-training purposes or if additional people are needed to conduct work in a timely, safe and efficient fashion. The program manager provides reciprocal assistance to these other programs.

3.3 Staff Qualifications and Training

The manager of the groundwater quality monitoring program must hold at least a four-year college degree in geology, geochemistry, hydrology, or a related scientific field and have substantial experience in the performance of groundwater quality studies and associated data analysis and statistical procedures. This individual must also understand the basic principles of program administration and quality control, possess advanced computer skills and written and oral communication skills, and command a thorough understanding of the procedures used in the collection, handling and preliminary analysis of groundwater samples and in the processing of associated paperwork and other documentation.

The program manager travels extensively throughout the state, obtaining water samples from literally hundreds of wells. Hence, this individual performs a valuable reconnaissance function and must be proficient in the identification and recognition of severe water quality problems warranting follow-up investigation and/or an emergency remedial response. The program manager must possess a valid Kansas driver's license and current certifications in first aid and cardiopulmonary resuscitation (CPR). From time to time, he/she may be directed to participate in additional training in applicable work procedures and/or related safety requirements. As funding and other agency resources allow, the program manager is encouraged to participate in technical workshops and seminars dealing with environmental monitoring operations and related field, analytical, data management, and statistical procedures.

Section 4

QUALITY ASSURANCE PROCEDURES

4.1 Monitoring Site Selection

This monitoring network is intended to provide a reliable and ongoing indication of groundwater quality conditions within each of the state's major aquifers (section 1.3). Toward that end, the following criteria are applied in the selection and replacement of network wells:

(1) New monitoring wells shall be added only to those physiographic regions and underlying major aquifers currently under represented in the monitoring network.

(2) New monitoring wells shall provide samples that are representative of the surrounding geographical area and that are not impacted by individual point sources or other localized pollution sources.

(3) Adequate construction information and/or well log records shall exist for all wells added to the monitoring network.

(4) New monitoring wells shall yield water at a rate of at least 10 GPM.

(5) All monitoring wells shall have a reasonable likelihood of continuous long-term usage (ten years or longer).

(6) New wells shall be readily accessible (generally approachable to within 100 meters by four-wheel drive vehicle under all but the most extreme weather conditions).

(7) New wells and associated pumping equipment shall be in good repair and have a reasonable likelihood of being properly maintained over the long-term.

(8) New wells shall have a sampling outlet close to the wellhead and up-line of any treatment (e.g., chlorination) equipment, if possible.

(9) The owner's permission shall be obtained prior to adding any new well to the groundwater quality monitoring network.

(10) Wells with historical water quality databases shall be preferentially incorporated into the monitoring network.

4.2 Field Protocols

Groundwater samples are collected from network wells by qualified KDHE personnel using protocols adapted from Wood (1976) and EPA (1985). These protocols are conveniently divided into the following five steps: (1) site verification; (2) well purging; (3) sample collection; (4) sample preservation; and (5) field analytical determinations. The following subsections summarize each of these steps, in turn. A detailed account of these procedures is provided in Appendix B.

4.2.1 Site Verification

Upon arrival at a monitoring site, the employee must verify that the well in question is actually included in the monitoring network and targeted for sampling. Each network well has a permanent metal tag stamped with a unique site identification number. This tag must be checked, and the site location must be confirmed using file photographs of the site and USGS topographical maps. Any changes to the well or pumping equipment since the last visit must be carefully recorded in the field notes.

4.2.2 Well Purging

Before a groundwater sample is collected, stagnant water must be purged from the well and the sampling valve must be adequately flushed. Water must be pumped until at least five well volumes are removed and the water temperature has stabilized. Stabilization is indicated when the temperature and pH of two consecutive readings, measured at least one minute apart, is within 1^{o}C and 0.1 pH unit, respectively. The amount of time required to accomplish this varies with well diameter, depth of water, pumping rates, and aquifer characteristics.

4.2.3 Sample Collection and Sample Containers

Raw or untreated groundwater samples shall be collected as close as possible to the wellhead. Chlorinator pumps and/or other water treatment devices must be turned off or unplugged from their power source if the injection lines enter the distribution system between the wellhead and the sampling point. In most cases, the sample valve location is documented within the site file.

A minimum of three sample containers are required at each site for the inorganic chemistry sample suite. These include (1) a one-quart (one-liter) plastic cubitainer for minerals, (2) a 175-ml Nalgene bottle for nutrients, and (3) a 250-ml Nalgene bottle for heavy metals. Depending on the sampling rotation schedule, additional containers may be required. These may include a one-gallon dark glass bottle with Teflon seal for pesticides, a 40-ml glass vial with Teflon seal for VOCs, a one-gallon plastic bottle and 20-ml plastic vial for radionuclides, and/or three 20-ml glass scintillation vials with high density polyethylene (HDPE) seals for radon (Appendix B).

4.2.4 Sample Preservation

The large plastic bottles for radionuclides, the glass VOC sample vials, and the Nalgene bottles for nutrients and heavy metals are acidified beforehand by staff of the Kansas Health and Environmental Laboratory (KHEL) to preserve the groundwater samples at the time of collection. Care must be taken when sampling to prevent overfilling the bottles containing acid. The VOC sample vials are filled to the top without aeration and must remain free of air bubbles. All nutrient, mineral cubitainer, pesticide, and VOC samples must immediately be placed in a cooler and packed with ice, pending transfer to KHEL.

4.2.5 Field Determinations

Groundwater temperature, pH, and electrical conductivity are measured in the field and recorded at the time of sampling. The thermometer, pH meter, and conductivity meter are calibrated in accordance with the appropriate SOPs in Appendix B. All instrument probes must be rinsed with distilled water before and after each measurement. Rinsing is accomplished by liberally directing a stream of demineralized water from a clean plastic squeeze bottle onto each instrument probe.

4.3 Sample Transport and Chain-of-Custody

All samples must be handled and stored in a manner which minimizes contamination, leakage and damage during transport. Samples are delivered to KHEL on the last day of the sampling run prior to the close of business. If field staff are unavoidably detained, every effort is made to contact KHEL by telephone to arrange for the late transfer of samples and to comply with the holding time requirements presented in tables 4.4-1, 4.4-2, 4.4-3 and 4.4-4, below. The impacts of any delays in sample submission are systematically investigated by the program manager and quantitatively addressed in routine program reports (section 4.11) and end-of-year program evaluations (QMP, Part I).

Standardized sample submission (chain-of-custody) forms are completed for all samples submitted to KHEL (Appendix C). These forms identify sampling location, date and time of sample collection, personnel involved in the collection of the sample, and analytical parameters of interest; they also assign to individual samples a unique identification number for future reference. The person involved with the collection and transfer of a sample signs and dates the form and delivers it with the sample to KHEL. Staff of KHEL sign the form, and record the date and time of submittal on the form, to acknowledge receipt of the sample. This basic sign-off procedure also is performed in the unlikely event a sample changes hands prior to arrival at KHEL.

4.4 Laboratory Analytical Parameters and Procedures

Analytical methods employed by KHEL and associated reporting limits are summarized in tables 4.4-1 through 4.4-4, below.

TABLE 4.4-1

ROUTINE COMPOSITE AND INORGANIC CHEMICAL PARAMETERS

CONSTITUENT OR PHYSICAL PROPERTY	REPORTING LIMIT	REPORTING UNIT	ANALYTICAL METHOD	HOLDING TIME
Alkalinity, total (as $CaCO_3$)	1	mg/L	EPA 310.2	14 days
Aluminum, total recoverable	0.05	mg/L	EPA 200.7	6 months
Ammonia, total (as N)	0.02	mg/L	EPA 350.1	28 days
Antimony, total recoverable	0.05	mg/L	EPA 200.7	6 months
Arsenic, total recoverable	1	μg/L	EPA 200.9	6 months
Barium, total recoverable	0.005	mg/L	EPA 200.7	6 months
Beryllium, total recoverable	0.001	mg/L	EPA 200.7	6 months
Boron, total recoverable	0.01	mg/L	EPA 200.7	6 months
Bromide	0.02	mg/L	EPA 300.0	28 days
Cadmium, total recoverable	1	μg/L	EPA 200.9	6 months
Calcium, total recoverable	0.05	mg/L	EPA 200.7	6 months
Chloride	0.01	mg/L	EPA 300.0	28 days
Chromium, total recoverable	1	μg/L	EPA 200.9	6 months
Cobalt, total recoverable	0.01	mg/L	EPA 200.7	6 months
Conductivity (field)	variable	μmhos/cm	GQMP SOP	immediate
Copper, total recoverable	1	μg/L	EPA 200.9	6 months
Fluoride	0.05	mg/L	EPA 300.0	28 days
Hardness, total (as $CaCO_3$)	calculated	mg/L	SM 2340B	N/A
Iron, total recoverable	0.01	mg/L	EPA 200.7	6 months
Lead, total recoverable	1	μg/L	EPA 200.9	6 months
Magnesium, total recoverable	0.05	mg/L	EPA 200.7	6 months
Manganese, total recoverable	0.005	mg/L	EPA 200.7	6 months
Mercury, total	0.0005	mg/L	EPA 245.2	13 days
Molybdenum, total recoverable	0.02	mg/L	EPA 200.7	6 months
Nickel, total recoverable	1	μg/L	EPA 200.9	6 months
Nitrate (as N)	0.01	mg/L	EPA 300.0	48 hours
Nitrite (as N)	0.05	mg/L	EPA 300.0	48 hours

pH (field)	0.1	pH unit	GQMP SOP	immediate
pH (laboratory)	0.1	pH unit	EPA 150.1	upon delivery
Phosphorus, total (as P)	0.01	mg/L	EPA 365.1	28 days
Potassium, total recoverable	0.05	mg/L	EPA 200.7	6 months
Selenium, total recoverable	2	μg/L	EPA 200.9	6 months
Silicon, total recov. (as SiO_2)	0.1	mg/L	EPA 200.7	6 months
Silver, total recoverable	1	μg/L	EPA 200.9	6 months
Sodium, total recoverable	0.05	mg/L	EPA 200.7	6 months
Sulfate	10	mg/L	EPA 300.0	28 days
Temperature (field)	1	degrees C.	GQMP SOP	immediate
Thallium, total recoverable	0.05	mg/L	EPA 200.7	6 months
Total dissolved solids	calculated	mg/L	USGS I751-8	N/A
Vanadium, total recoverable	0.005	mg/L	EPA 200.7	6 months
Zinc, total recoverable	0.005	mg/L	EPA 200.7	6 months

TABLE 4.4-2

ROUTINE PESTICIDES AND RELATED COMPOUNDS

CONSTITUENT OR PHYSICAL PROPERTY	REPORTING LIMIT	REPORTING UNIT	ANALYTICAL METHOD	HOLDING[1] TIME
Acetochlor	0.1	μg/L	EPA 608	7 days
Alachlor	0.1	μg/L	EPA 608	7 days
Aldrin	0.025	μg/L	EPA 608	7 days
Atrazine	0.3	μg/L	EPA 608	7 days
Butachlor	0.5	μg/L	EPA 608	7 days
Carbofuran	0.5	μg/L	EPA 608	7 days
Chlordane	0.2	μg/L	EPA 608	7 days
Cyanazine	0.5	μg/L	EPA 608	7 days
DCPA	0.05	μg/L	EPA 608	7 days
p,p’-DDD	0.04	μg/L	EPA 608	7 days
p,p’-DDE	0.02	μg/L	EPA 608	7 days
p,p’-DDT	0.1	μg/L	EPA 608	7 days

Dieldrin	0.05	μg/L	EPA 608	7 days
Endosulfan I	0.02	μg/L	EPA 608	7 days
Endosulfan II	0.02	μg/L	EPA 608	7 days
Endosulfan sulfate	0.1	μg/L	EPA 608	7 days
Endrin	0.1	μg/L	EPA 608	7 days
alpha-BHC	0.025	μg/L	EPA 608	7 days
beta-BHC	0.05	μg/L	EPA 608	7 days
delta-BHC	0.05	μg/L	EPA 608	7 days
gamma-BHC	0.025	μg/L	EPA 608	7 days
Heptachlor	0.02	μg/L	EPA 608	7 days
Heptachlor epoxide	0.02	μg/L	EPA 608	7 days
Hexachlorobenzene	0.1	μg/L	EPA 608	7 days
Methoxychlor	0.2	μg/L	EPA 608	7 days
Metolachlor	0.25	μg/L	EPA 608	7 days
Metribuzin	0.1	μg/L	EPA 608	7 days
PCB-1016	0.5	μg/L	EPA 608	7 days
PCB-1221	1	μg/L	EPA 608	7 days
PCB-1232	0.5	μg/L	EPA 608	7 days
PCB-1242	0.5	μg/L	EPA 608	7 days
PCB-1248	0.5	μg/L	EPA 608	7 days
PCB-1254	0.5	μg/L	EPA 608	7 days
PCB-1260	0.5	μg/L	EPA 608	7 days
Picloram	0.8	μg/L	EPA 615	7 days
Propachlor	0.25	μg/L	EPA 608	7 days
Propazine	0.3	μg/L	EPA 608	7 days
Silvex, as acid (2,4,5-TP)	0.4	μg/L	EPA 615	7 days
Simazine	0.3	μg/L	EPA 608	7 days
Toxaphene	2	μg/L	EPA 608	7 days
2,4-D, as acid	0.8	μg/L	EPA 615	7 days
2,4,5-T, as acid	0.4	μg/L	EPA 615	7 days

[1]Pesticide samples must be extracted within 7 days of collection and analyzed within 40 days of extraction.

TABLE 4.4-3

VOLATILE ORGANIC COMPOUND (VOC) PARAMETERS

CONSTITUENT OR PHYSICAL PROPERTY	REPORTING LIMIT	REPORTING UNIT	ANALYTICAL METHOD	HOLDING TIME
Benzene	0.5	μg/L	EPA 624	14 days
Bromodichloromethane	0.5	μg/L	EPA 624	14 days
Bromoform	0.5	μg/L	EPA 624	14 days
Bromomethane	0.5	μg/L	EPA 624	14 days
Chlorobenzene	0.5	μg/L	EPA 624	14 days
Chloroethane	0.5	μg/L	EPA 624	14 days
Chloromethane	0.5	μg/L	EPA 624	14 days
Dibromochloromethane	0.5	μg/L	EPA 624	14 days
1,2-Dichlorobenzene	0.5	μg/L	EPA 624	14 days
1,3-Dichlorobenzene	0.5	μg/L	EPA 624	14 days
1,4-Dichlorobenzene	0.5	μg/L	EPA 624	14 days
1,1-Dichloroethane	0.5	μg/L	EPA 624	14 days
1,2-Dichloroethane	0.5	μg/L	EPA 624	14 days
1,1-Dichloroethylene	0.5	μg/L	EPA 624	14 days
cis 1,2-Dichloroethylene	0.5	μg/L	EPA 624	14 days
trans 1,2-Dichloroethylene	0.5	μg/L	EPA 624	14 days
Dichloromethane	0.5	μg/L	EPA 624	14 days
1,2-Dichloropropane	0.5	μg/L	EPA 624	14 days
cis 1,3-Dichloropropene	0.5	μg/L	EPA 624	14 days
trans 1,3-Dichloropropene	0.5	μg/L	EPA 624	14 days
Ethylbenzene	0.5	μg/L	EPA 624	14 days
1,1,2,2-Tetrachloroethane	0.5	μg/L	EPA 624	14 days
Tetrachloroethylene	0.5	μg/L	EPA 624	14 days
Tetrachloromethane	0.5	μg/L	EPA 624	14 days
Toluene	0.5	μg/L	EPA 624	14 days
1,1,1-Trichloroethane	0.5	μg/L	EPA 624	14 days

1,1,2-Trichloroethane	0.5	μg/L	EPA 624	14 days
Trichloroethylene	0.5	μg/L	EPA 624	14 days
Trichloromethane	0.5	μg/L	EPA 624	14 days
Vinyl chloride	0.5	μg/L	EPA 624	14 days
Xylene	0.5	μg/L	EPA 624	14 days

TABLE 4.4-4

RADIOLOGICAL PARAMETERS

CONSTITUENT OR PHYSICAL PROPERTY	REPORTING LIMIT	REPORTING UNIT	ANALYTICAL METHOD	HOLDING TIME
Gross Alpha	1	pCi/L	EPA 900.0	6 months
Gross Uranium	1	pCi/L	EPA 908.0	6 months
Radium-226	0.3	pCi/L	EPA 903.1	6 months
Radium-228	1.2	pCi/L	EPA 904.0	6 months
Radon-222	25	pCi/L	EPA 913.0	4 days

4.5 Internal Procedures for Assessing Data Precision, Accuracy, Representativeness and Comparability

4.5.1 In-house Audits

The section chief conducts annual audits of field and laboratory equipment and procedures. Each audit is comprised of (1) a system audit, consisting of a qualitative, onsite review of QA systems and physical facilities for monitoring, measurement and calibration and (2) a performance audit, in which a quantitative assessment is made of the bias (accuracy) and variability (precision) of analytical measurements. During system audits, staff responsible for sample collection and field operations are required to demonstrate a proper understanding of the requirements imposed by the QA management plan and accompanying SOPs. During performance audits, staff are required to conduct field measurements in the presence of the section chief and to report measured values for pH, electrical conductivity, and temperature that fall within five percent of the values established by the section chief. Should these values fall outside the control limits, the section chief and field worker initiate corrective actions as described in section 4.7.

4.5.2 Instrument Calibration and Standardization

At monthly intervals during the field season, the performance of field thermometers is checked against a reference thermometer traceable to the National Institute of Standards and Technology (NIST). Before leaving for the field, the program manager is expected to calibrate the conductivity and pH meters and test the instruments for normal operation. The pH meter is standardized immediately prior to use in the field using NIST-traceable pH buffer solutions (Appendix B). The pH and conductivity meters must meet all manufacturer performance specifications. Should meters be found to drift significantly, more frequent calibrations are performed or corrective action procedures are invoked (section 4.7.1).

4.5.3 Field Blanks

The possibility of sample contamination during sample preparation, handling, storage and analysis is assessed through the use of field blanks, prepared with demineralized water and subjected to the same treatment as groundwater samples. (Contamination is an especially important consideration when sampling for trace metals and metalloids, as ambient concentrations of these parameters are often less than 1.0 μg/L, and sample concentrations may be greatly augmented through exposure to airborne particulate matter, etc.) For approximately every twenty wells sampled, a complete set of sample containers is selected at random, filled under field conditions with demineralized water initially meeting ASTM Type-I specifications, and subjected to the same preservation, handling, storage and analysis procedures as the actual field samples (Appendix B). If the limits for sample contamination presented in section 2, paragraph (1), are exceeded, corrective actions are implemented in accordance with section 4.7.2.

4.5.4 Field Duplicate Samples and Spiked Samples

Quality control measures implemented in the field also include the collection of duplicate samples and preparation of spiked samples. Duplicate samples are obtained from approximately one out of every ten wells visited by field staff. At least two times each sampling season, a set of spiked samples is prepared in the field through the addition of known concentrations of selected parameters to one of the sets of duplicate samples. Later, following laboratory analysis, measured levels of the selected parameters in spiked samples are compared to those in the unamended duplicates to provide an overall indication of sample degradation and analytical recovery. Field spikes are prepared using high accuracy and high precision fixed- and adjustable-volume pipettes, volumetric glassware, and certified reference standards obtained from EPA, USGS or appropriate commercial vendors (Appendix B). Should the precision and/or accuracy of the data fall outside the control limits established in section 2, paragraph (1), corrective action procedures are invoked in accordance with section 4.7.3, below.

4.5.5 Preventative Maintenance

Periodic inspection of sampling and analytical equipment and routine maintenance of this equipment is necessary to minimize malfunctions which could result in the loss of data or disrupt program activities. Field instrumentation must routinely be inspected prior to use and calibrated at intervals recommended by the manufacturer. Equipment maintenance logs must be maintained for all field thermometers and pH and conductivity meters. Vehicles used for field activities must be maintained in a reliable condition and kept free of trash, debris or other materials that could significantly increase the risk of sample contamination. Entries must be made in the vehicle log upon completion of each field trip. Instrument and vehicle malfunctions shall be reported to the program manager as soon as possible to expedite necessary repairs or the acquisition of new equipment (section 4.7).

4.5.6 Safety Considerations

Attention to job safety protects the health and well-being of program staff and helps maintain a work atmosphere which ultimately enhances data quality and consistency. Program staff must be familiar with proper precautionary measures and the use of available safety equipment prior to assuming field duties. All vehicles used in the groundwater quality monitoring program must be maintained in proper operating condition and equipped with a first aid kit, safety goggles, portable eye wash station, fire extinguisher, spare tire and tire changing equipment, rain gear, emergency road reflectors and/or flares, and at least one operable flashlight. Field staff are expected to check out cellular phones from BEFS clerical staff on a routine basis, in the event of vehicle mishaps, medical problems, or other emergencies in the field. The use of a cellular phone is especially important when traveling alone, conducting overnight sampling runs, or when traveling during periods of potentially severe weather.

Care must be taken when handling glassware and chemical reagents in the field. Chemicals reagents used in the field include concentrated nitric and sulfuric acid preservatives (strong acids and oxidizers) and pH buffer solutions (eye and mucous membrane irritants). Staff should not engage in the use of these reagents or breakable glassware if the weather, terrain, traffic or any other concern impedes concentration, reduces visibility, jeopardizes footing, or otherwise precludes the safe handling of these materials. Rather, staff should move to a level, dry , protected, and well lighted area before preserving or analyzing samples. If the wind is blowing strongly, staff should avoid handling samples and reagents immediately upwind of their face and eyes. Additional safety considerations are presented in the SOPs accompanying this QA management plan.

4.6 External Procedures for Assessing Data Precision, Accuracy, Representativeness and Comparability

At the discretion of the section chief, bureau QA representative or other administrative staff, the groundwater quality monitoring program may, from time to time, participate in independent audits or in cooperative, interlaboratory sample comparison programs or reference sample programs. Participation in such activities promotes scientific peer review and enhances the technical integrity and overall credibility of the program.

4.7 Corrective Action Procedures for Out-of-Control Situations

4.7.1 Equipment Malfunction

Any instrument malfunction discovered by staff during routine calibration activities or during an internal or external performance audit shall be recorded in the appropriate logbook and immediately reported to the program manager. The program manager is responsible for appraising the scope and seriousness of the problem and, if necessary, for determining whether the instrument should be repaired or replaced. The program manager also is responsible for ensuring that backup instrumentation is available for all critical field activities. Similarly, arrangements for a backup sampling vehicle must be made in advance of any mechanical problems or mishaps that might render the vehicle inoperable for an extended period.

4.7.2 Sample Contamination

Blank concentrations outside the control limits established in section 2, paragraph (1), detract from the quality and credibility of the groundwater quality data and must be resolved in a timely manner. In instances where the source of the contamination is unknown, the program manager shall initiate an investigation to determine whether the problem is of likely field or laboratory origin. Field contamination problems may result, for example, from improper sample collection technique or exposure to contamination sources at the sampling site or within the vehicle used to transport the samples. Laboratory problems may include contaminated water supply or reagents, contaminated glassware, or some less conspicuous problem. The program manager shall work closely with KHEL personnel to identify and eliminate any serious contamination sources. Persistent problems shall trigger a program audit by the section chief and ultimately may result in the removal of questionable data from the groundwater chemistry database.

4.7.3 Data Precision/Accuracy Problems

Should groundwater quality data fail to meet the precision and accuracy requirements of section 2 paragraph (1), the program manager shall initiate an investigation to determine the cause of the problem. The program manager shall work closely with KHEL to identify the cause and implement appropriate corrective measures. Persistent problems may trigger a program audit by the section chief, result in the disqualification of a substantial amount of groundwater quality data, or invoke other remedial measures (e.g., independent audit).

4.7.4 Staff Performance Problems

Should a member of the program staff have difficulty with a given work procedure (e.g., as determined by an internal performance audit), an effort shall be made by the program manager and unit chief to identify the scope and seriousness of the problem, to identify any data affected by the problem, and to recommend to the section chief an appropriate course of corrective action. All questionable data are either flagged within the computer database or, at the discretion of the section chief, deleted from the database. Possible corrective actions include, but are not necessarily limited to, further in-house or external training for the employee, a reassignment of work duties, or modification of the work procedure.

4.8 Data Management

4.8.1 General Data Management

All field- and laboratory-generated data on groundwater chemistry are handled in an orderly and consistent manner. Time and date of sample collection, monitoring well identification number, and other basic information is recorded on standardized sample submission forms and field sheets (Appendix C). Original forms are retained by the program manager for filing; original forms are submitted to KHEL along with the samples. Photocopies of the sample submission forms are retained by KHEL along with the samples (Appendix C). Upon completion of the laboratory analyses, the KHEL Data General "Avionics" computer automatically downloads data to the Kansas Water Database, which is accessed through the KDHE IBM AS-400 computer system. Data files are processed using in-house conversion programs to convert data from ASCII flat files to the Kansas Water Database storage format. The Kansas Water Database is supported and backed-up daily by the KDHE Office of Information Systems (OIS).

Hardcopies of all chemical analysis reports generated by KHEL are stored in the BEFS files. These data are reviewed by the program manager for any obvious errors or omissions. Information derived from field QC samples (duplicates, spikes, blanks, etc.) are subjected to particularly thorough review. With the approval of the unit chief, data that are deemed inaccurate or grossly unrepresentative are purged from the electronic database (section 4.8.4, below). Redundant forms of data storage and backup (e.g., EPA STORET system, Kansas Water Database, KHEL tape files, BEFS hardcopy files) help to ensure the long-term integrity and availability of the program data.

Newly acquired data are transferred electronically from the Kansas Water Database to the EPA STORET database at least once each year. Prior to this transfer, an EPA computer program called "Rum-dum" scans the data and identifies any value that is outside the historical range for a given parameter and monitoring well. This value is not entered into the EPA STORET database but is reported to BEFS for further investigation and validation. The manager of the groundwater quality monitoring program compares this value to that recorded on the original field sheet and/or laboratory reporting form. He/she also may consult with other program personnel and/or KHEL analytical staff and consider any relevant (field or laboratory) QC documentation. If the value is ultimately deemed erroneous or suspect, it is removed from the Kansas Water Database and not entered into the EPA STORET database. If it is deemed valid, the Rum-dum program is modified to accept the value and accommodate the new range of historical values for the parameter and monitoring well in question.

4.8.2 Data Entry Requirements

The program manager manually enters data for field pH, temperature, and electrical conductivity into the Kansas Water Database. All entered values are examined and verified by the program manager via comparison to the original field sheets. In transferring or receiving any data electronically, the program manager also performs random spot checks of the data and reports any problems to KHEL, OIS and/or EPA for further investigation and resolution. Persistent problems are reported to the unit chief, section chief and bureau QA representative for consideration of necessary corrective actions.

4.8.3 Verification of Calculations

Computer-based mathematical, statistical, graphical and geographical programs and models involving environmental data are tested before application by comparison to other computer programs, through hand calculations involving randomly selected data, or through other appropriate means. The reliability of these models and programs is reexamined on at least an annual basis or whenever a problem is reported within a computational system. Quattro Pro, Excel, ArcView and PC SAS are among the forms of software used for generating spreadsheets, graphs and maps and for performing statistical characterizations, comparisons and trend analyses.

4.8.4 Data Transformation, Outliers and Reporting Limits

Many forms of environmental data do not conform to a normal distribution and may necessitate the use of nonparametric statistical methods. Alternatively, the data may be transformed statistically to induce a normal or log normal distribution or some other preferred data distribution. In general, data are first graphed to reveal the general shape of the distribution and to help identify the most appropriate transformation procedure. Commercially available computer programs may be applied in more detailed assessments of data distribution. PC SAS software maintained on one of the BEFS desk top computers offers several algorithms for characterizing departure from normality (e.g., Shapiro-Wilk and Kolomogorov tests available through the UNIVARIATE procedure).

Water quality data occasionally may include anomalous values or statistical outliers. Obvious outliers (those that are orders of magnitude beyond any reasonable value) often constitute data transcription errors or measurement unit conversion errors. In other instances, outliers may reflect the gross contamination of samples, analytical errors, or an actual (though rarely occurring) fluctuation in water quality. In the groundwater quality monitoring program, data are automatically questioned by the program manager if reported duplicate concentrations vary by more than 30 percent or if a value is outside the historical range for the parameter and monitoring site in question. If follow-up consultations with field, laboratory, and data management personnel provide no reasonable explanation for a questionable value, the program manager may flag the value or delete the value from the database.

Parameter concentrations that are less than the applicable minimum reporting limit (MRL) established by KHEL tend to complicate data analysis. Although a hypothetical value of one-half the MRL may be assigned to facilitate statistical examination, the MRL itself, or a value of zero, may be more appropriate in some applications. Nonparametric procedures based on rank-order or percentiles tend to be less influenced by these kinds of data and are often favored by staff performing statistical characterizations, comparisons and trend analyses.

4.8.5 Ancillary Data

Ancillary data used in this program may include the original well logs and geological, hydrological, or meteorological data derived from other state or federal agencies. If data are obtained from an outside agency, an effort is made to ensure that an appropriate QA plan has been prepared and implemented in the procurement of the data. In some instances, outside agencies collect data under contract to KDHE, or under the auspices of an EPA grant, both of which require development and approval of a quality assurance project plan (QAPP) prior to data collection (see QMP, Part I, section 2.3). Aquifer permeability coefficients and other geophysical measurements may be applied by staff in modeling calculations. These values are normally obtained from published governmental documents or from other literature sources incorporating scientific peer review of articles before publication. Program staff carefully examine the underlying technical assumptions before applying these coefficients and values in modeling calculations.

4.9 Quality Assurance Reporting Procedures

End-of-year program evaluations are conducted by the section chief, and a written report is submitted to the bureau QA representative, bureau director and divisional QA officer by February 15 of the following year. The program manager cooperates in this evaluation and makes available all records gathered during the evaluation period on the precision, accuracy, representativeness and comparability of the monitoring data. Program evaluations submitted by the section chief indicate when, how, and by whom the evaluation was conducted, the specific aspects of the program subjected to review, a summary of significant findings, and technical recommendations for necessary corrective actions. The section chief discusses the reported findings with the program manager and unit chief.

4.10 Purchased Equipment and Supplies

When newly ordered or repaired sampling, analytical or computational equipment is delivered to the program office, the program manager compares the item to that requested on the original order, then inspects the equipment to ensure no breakage has occurred in transit and all components function properly. Once this inspection is completed, the manager either accepts or rejects the shipment. Office and laboratory supplies receive a comparable level of scrutiny. Reference standards and equipment must be accompanied by a certificate from the vendor or manufacturer verifying the quality of these products.

4.11 Program Deliverables

A comprehensive program report is prepared by the program manager every six years. Each report analyzes the chemical data obtained during the preceding six-year period from each of the state's major aquifers. Emphasis is placed on the determination of any significant spatial or temporal trends in groundwater chemistry (section 1.3). Groundwater quality conditions also are evaluated with respect to conformity with applicable state and federal water quality standards and guidelines. Each draft report undergoes an intensive in-house review and is revised accordingly. Upon approval by the division director, the final report is printed and distributed to a variety of natural resource agencies and other interested groups and individuals around the state.

Program deliverables also include electronic databases, illustrative materials, statistical water quality summaries, and additional written reports used in a variety of agency applications. Groundwater quality data play a major role in the development of the Kansas biennial water quality assessment (i.e., 305(b) report). Also, as resources and circumstances allow, customized data retrievals are prepared by the program manager on behalf of administrative staff, legislative officials, other state and federal agencies, regulated entities, special interest groups, consultants, academicians, students, and members of the general public. The program manager also sends copies of KHEL analysis reports for private water supply network wells to the owners of these wells as a courtesy for participation in the program.

Section 5

REVIEW AND REVISION OF PLAN

To ensure that the groundwater quality monitoring program continues to meet the evolving informational needs of the bureau and the agency, all portions of this QA management plan and its appended SOPs must be comprehensively reviewed by participating staff on at least an annual basis. Revisions to the plan and SOPs require the approval of the program manager, unit chief, section chief, and bureau QA representative prior to implementation. Although review and revision activities normally follow the annual program evaluation in February, these activities may be implemented at any time based on urgency of need or staff workload considerations.

Original approved versions of the QA management plan and SOPs, and all historical versions of these documents, are maintained by the bureau QA representative or his/her designee. The bureau QA representative also maintains an updated electronic version of the plan and SOPs on the KDHE internet server in a "read only" .pdf format.

APPENDIX A

FIELD EQUIPMENT AND SUPPLY CHECKLIST

FIELD EQUIPMENT AND SUPPLY CHECKLIST

I. VEHICLE

A. Four-wheel drive pickup truck with camper top, or other vehicle as available

B. Proof of liability insurance for vehicle (issued by Central Motor Pool)

C. Vehicle log book (credit card, Fuelman card, list of Fuelman service stations, copy of tire and battery service contracts)

D. Vehicle key and spare key(s)

E. Mobile cellular telephone with magnetic mountable antenna, carrying case, instructions

F. Flourescent orange safety vest with reflective strips, orange or yellow rain coat or poncho with reflective strips; rubber boots

G. Fire extinguisher, first aid kit, CPR mouthpieces, latex rubber gloves, paper and cloth towels, hand sanitizing solution in plastic squeeze bottle, safety goggles, portable eyewash station

H. Spare tire (fully inflated), tire changing equipment, road reflectors and/or flares

II. OTHER FIELD EQUIPMENT AND SUPPLIES

A. Stainless-steel pail (1 gal)

B. Coleman ice chests (100-qt capacity), containing bags of crushed ice

C. Wooden flat for sample container storage

D. Plastic tub for sample handling and transport

E. Sample containers (including two or more sets of spare containers)

F. Glass beakers (50 ml)

G. Polyethylene disposable gloves

H. Demineralized water (in squeeze bottle and cubitainers)

I. Clipboard (with maps, field sheets, etc.), pencils, pens, markers and labeling tape

J. Polaroid instant camera or other camera, as available

K. Fiberglass survey tape (100 ft)

L. Metal well tags, portable rechargeable hammer drill, drill bits, fasteners, hand tools

M. Safety goggles, hearing protection (ear muff style), gloves

III. FIELD MEASUREMENT APPARATUS

A. Ashtech “Reliance” global positioning system (GPS) backpack receiver (with Psion data logger, antenna and carrying case)

B. Fisher model #15-0778 stainless-steel dial scale thermometer (-10 to +110 ^{o}C)

C. Cole-Parmer model #5996-70 field pH meter (analog readout with instruction manual, carrying case, combination pH probe, and pH 4, 7 and 10 buffer solutions)

D. Fisher model #09-327-1 field conductivity meter (digital readout with instruction manual, carrying case, and conductivity probe)

APPENDIX B

STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

[1]The designation "(R)" indicates a procedure or set of procedures has been rescinded or incorporated into another SOP.

GLOBAL POSITIONING SYSTEM (GPS) PROCEDURES FOR DETERMINATION OF GEOGRAPHICAL LOCATION OF GROUNDWATER QUALITY MONITORING SITES (GQMP-001)

I. INTRODUCTION

A. Purpose

Accurate documentation of geographical position (longitude and latitude) reduces the risk of obtaining samples from the wrong monitoring site and facilitates the analysis of monitoring data through geographical information system (GIS) techniques. The location of all monitoring sites included in the KDHE groundwater quality monitoring network must be precisely documented using GPS procedures.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the use of GPS equipment and possess a basic understanding of the underlying technology.

C. Equipment/Accessories

1. Carry bag or case
2. Receiver back pack
3. Ashtech "Reliance" GPS receiver
4. Psion data logger
5. Psion coiled cable, 1.3 m
6. Protective cover for data logger
7. Receiver batteries, 12 v (2)
8. Receiver battery connector
9. Auxiliary battery connector (vehicle)
10. Remote battery chargers (2)
11. Antenna, adapter, and magnetic base
12. Antenna poles, 11 cm and 47 cm
13. Antenna cable, 2.5 m
14. Receiver download cable

II. PROCEDURES

A. Equipment Set-Up and Operation

Procedures described in the Ashtech Reliance (Submeter) GPS System Guide, which may be viewed on the KDHE intranet server (GIS section), are adopted by reference.

B. Equipment Take-Down and Data Processing

Procedures described in the Ashtech Reliance (Submeter) GPS System Guide, which may be viewed on the KDHE intranet server (GIS section), are adopted by reference.

VEHICLE SAFETY AND MAINTENANCE PROCEDURES (GQMP-002)

I. INTRODUCTION

A. Purpose

The following text outlines vehicle safety and maintenance procedures used during the collection and transport of groundwater chemistry samples. Safety procedures are established to prevent or minimize property damage, personal injuries, and/or loss of life. Maintenance procedures are established to prevent or minimize vehicle breakdowns and to extend the usable life of the vehicle. Accidents and mechanical failures are costly and result in loss of productivity.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should possess a valid Kansas driver's license and current certifications in both standard first aid and cardiopulmonary resuscitation (CPR). Although not required, these employees are strongly encouraged to participate in defensive driving courses offered by some law enforcement agencies and other qualified organizations.

C. Equipment/Accessories

Four-wheel drive pickup truck with camper top over bed, emergency flashing lights, portable emergency road reflectors or road flares, fire extinguisher, spare tire, tire changing equipment, jumper cables, tow rope, tool kit, first aid kit, disposable latex gloves, disposable CPR mouthpiece, safety goggles, emergency eyewash station, operable flashlight, windshield ice scraper, cellular phone with magnetic mountable antenna, AM/FM radio, and all other equipment indicated in Appendix A.I. (Note: any other vehicle driven by program staff while engaged in groundwater monitoring operations should include comparable safety equipment and accessories, with the exception of four-wheel drive capability and the camper top, which are installed only on the primary sampling vehicle.)

II. PROCEDURES

A. Vehicle Safety Procedures

1. The following conditions and safety precautions must be met and observed while operating motor vehicles in association with groundwater quality monitoring operations:

a. Vehicle operators must possess a valid Kansas driver's license.

b. Drivers shall abide by all applicable regulations for operation of motor vehicles.

c. SEAT BELTS MUST BE WORN AT ALL TIMES WHILE OPERATING OR RIDING IN MOTOR VEHICLES.

d. Drivers shall observe posted speed limits. Upon encountering slippery road conditions, high winds, reduced visibility, road construction, heavy traffic, slower traffic (e.g., farm or construction vehicles, bicycles, pedestrians, saddle horses, horse drawn carriages, trucks with oversized loads, military convoys, etc.) or other conditions warranting greater caution, drivers shall slow to a reasonable and prudent speed.

e. Driver's shall avoid tailgating or "drafting" and observe proper driving intervals behind the vehicle ahead.

f. Drivers shall pass other vehicles only where the safety and legality of passing is not in doubt.

g. Electrical turn signals or, in emergencies, proper hand signals shall be used when operating vehicles.

h. Drivers shall become familiar with vehicle manufacturer’s operating instructions and drive vehicle accordingly.

2. Vehicles shall be checked for any apparent safety problems before and after each sampling trip. Vehicles with potentially serious operational defects shall not be used for sampling events. Concerns about vehicle safety shall be directed immediately to the unit chief or higher level supervisor.

3. Vehicles shall not be operated when the driver has been on the job for more than ten hours or when the driver is exhausted, ill, or taking medications or drugs that may cause drowsiness or impair sensory functions, reflexes or reasoning.

4. Cargo transported in sampling vehicles shall not be stacked higher than the driver and passenger seat backs, even in vehicles equipped with cargo safety screens.

5. Safety equipment indicated in paragraph I.C, above, shall be maintained in all agency vehicles used for groundwater quality monitoring operations.

6. When obtaining samples or performing related reconnaissance activities, sampling vehicles shall not be parked in any location or in any manner that may create a traffic hazard, impede the flow of traffic, or constitute a danger to the vehicle driver, passengers, occupants of other vehicles, or pedestrians.

B. Vehicle Maintenance Procedures

1. The sampling vehicle shall be scheduled for normal service maintenance every 5,000 miles. Routine maintenance is performed by the Central Motor Pool and typically includes changing of oil and oil filter, lubrication of chassis and suspension, checking of fluid levels/antifreeze strength, rotation of tires, and inspection of belts, hoses, tires, shocks and/or struts, brakes, air conditioner, heater, exterior lights, windshield wipers, and exhaust system. Other repairs are performed as needed.

2. Other routine maintenance, such as tune-ups, air and fuel filter replacement, wheel bearing inspection and grease repacking, "wheels off" brakes inspection, etc. shall be performed according to the vehicle manufacturer's recommendations. This information may be obtained either in the vehicle owner's manual or by contacting the Central Motor Pool.

3. All emergency repairs, unscheduled maintenance, or towing shall be performed by the Central Motor Pool, unless the vehicle is being utilized outside the Topeka vicinity. Minor "on the road" repairs costing less than $200.00 (parts and labor) may be done by any qualified and authorized facility. If the repair estimates are greater than $200.00, the Central Motor Pool must be contacted for approval prior to having any work done.

4. The purchase of tires and batteries is covered under State contract. A list of authorized vendors and acceptable types of tires or batteries may be found within the Central Motor Pool Automotive Battery Contract and Tire Contract. Copies of the current contracts shall be attached to the vehicle log clipboard.

5. An adequate supply of fuel shall be maintained in the gas tank at all times. Fuel can only be purchased with the FUELMAN card at FUELMAN locations. A current FUELMAN directory shall be attached to the vehicle clipboard. The Central Motor Pool is an official FUELMAN location that provides fuel at a price lower than other FUELMAN locations in Topeka. When purchasing gasoline away from Topeka, confirm that the vendor is an approved FUELMAN vendor prior to pumping fuel. During the refueling

process, clean the windshield if necessary. If time permits, it is a good idea to check the engine oil level and visually inspect the tires.

Exceptions to the FUELMAN rule for monitoring program staff are as follows:

a. Each vehicle has a white state credit card that is a "backup" card to be used **only** in those circumstances when a FUELMAN location is not within a feasible driving distance. Again, it is best to verify that the facility will accept the card prior to pumping fuel into a vehicle. If using the white state credit card, only purchase fuel from self-service gasoline pumps.

b. Fuel may be purchased with the white state credit card from state operated refueling stations at the University of Kansas in Lawrence, Kansas State University in Manhattan, or the State Correctional Facility in Lansing.

6. The vehicle log shall be updated each time the vehicle is utilized by entering the appropriate date, operator's name, mileage, and destination. All vehicle purchases and/or repair costs shall also be reported in the vehicle log. The vehicle logs and accompanying receipts shall be turned over to the KDHE Business Office on a monthly basis.

OPERATIONAL AND MAINTENANCE PROCEDURES FOR FIELD ANALYTICAL EQUIPMENT (GQMP-003)

I. INTRODUCTION

A. Purpose

The following text establishes standard procedures for the proper care, calibration, and maintenance of field pH meters, conductivity meters, and thermometers.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of groundwater and have a basic technical understanding of the associated measurement apparatus.

C. pH Meter Specifications

Manufacturer:	Cole-Parmer
Instrument type:	Portable Analog pH Meter
Model number:	5996-70
Range:	0 to 14 pH Units
Resolution:	0.01 pH Units

D. Conductivity Meter Specifications

Manufacturer:	Fisher Scientific Company
Instrument type:	Portable Digital Conductivity Meter
Model number:	09-327-1
Range selection:	1) 0-200 μmhos/cm
	2) 0-2,000 μmhos/cm
	3) 0-20,000 μmhos/cm
	4) 0-200,000 μmhos/cm
Resolution:	1-1,000 μmhos/cm, depending on selected range

E. Thermometer Specifications

Manufacturer:	Fisher
Instrument type:	Dial scale thermometer
Model number:	15-0778
Range:	-10 to +110 degrees Celsius (^{o}C)
Resolution:	1^{o}C

II. PROCEDURES

A. pH Meter

The field pH instrument features battery operation, two point standardization, and manual temperature compensation. It is used in conjunction with a combination glass/calomel reference pH electrode. When properly calibrated, standardized, and compensated with respect to temperature, it provides an accurate analog readout of sample pH, defined as the negative logarithm of the hydrogen ion activity in moles per liter. In most groundwater samples and other dilute solutions, hydrogen ion activity is essentially identical to hydrogen ion concentration.

1. pH Meter Calibration and Standardization

   a. Meter is factory calibrated but may require zeroing of readout needle. Check needle position with meter turned off. If needle does not read zero, then use mechanical zero screw to adjust needle to zero.

   b. Connect pH electrode to instrument and remove electrode cap.

   c. Immerse electrode in pH 7 buffer solution and turn meter on. Stir electrode gently while adjusting **SET** control for a reading of 7.00. Allow reading to stabilize before proceeding to next step.

   d. Rinse the electrode thoroughly in demineralized water, and gently shake off excess water.

   e. Immerse electrode in either pH 4 or pH 10 buffer solution.

   f. Allow a few seconds for the reading to stabilize, then adjust **SLOPE** control for a pH reading of 4.00 or 10.00 (depending on buffer used).

   g. Rinse the electrode in demineralized water, and shake off excess water.

   h. Meter is now calibrated, standardized, and ready to use.

   NOTE: The above steps should be repeated at beginning of each day of a sampling run. Measure pH of 7.00 buffer at intervals during day as an additional safeguard. If zeroing and standardization are necessary, also repeat steps d-h, above.

2. pH Meter Operation

a. After above procedures are completed, immerse electrode in sample. Set temperature knob to sample temperature (measured with Fisher model #15-0778 stainless-steel dial scale thermometer; see below). Gently stir electrode, and allow time for pH reading to stabilize.

b. After stabilization, read the analog display for sample pH. Record indicated pH value on field data sheet.

c. Using plastic squeeze bottle filled with demineralized water, rinse electrode tip and barrel thoroughly. Immerse electrode bulb and lower barrel in 50-ml beaker of demineralized water between sample measurements.

3. pH Meter Inspection and Maintenance

a. Proper calibration of instrument must be confirmed prior to each field trip. If meter is malfunctioning, a backup meter must be used pending repair or replacement of original meter.

b. Routine maintenance includes periodic electrode and battery replacement. At a minimum, batteries and electrodes must be replaced annually. All maintenance checks and electrode/battery replacements must be recorded in instrument log book.

c. If electrode becomes dirty or if a crust develops, rinse thoroughly with demineralized water or stir electrode in water and detergent solution. **DO NOT** abrade electrode by wiping or cleaning with cloths or paper towels. For protein layers, wash electrode tip with pepsin or 0.1N hydrochloric acid (HCl); for inorganic deposits, wash with ethylenediaminetetracetic acid (EDTA) or other weak acid; and for grease or similar films, wash with acetone, methanol or diethyl ether in appropriately ventilated area well removed from any open flame.

d. Record all operational problems, routine maintenance actions, and instrument repairs in instrument log book.

B. Conductivity Meter

The portable conductivity meter is a battery operated instrument used to directly measure conductivity in μmho/cm. The probe contains an internal thermistor, and the meter automatically compensates for temperature variations among samples. The meter operates in four ranges selectable with a front panel switch.

1. Conductivity Meter Calibration

   a. Replace meter battery if meter reads **LO BAT**, provides erratic reading, or fails to produce any digital display.

   b. At beginning of each field season, place probe in freshly prepared 0.01M potassium chloride solution, warmed or cooled to 25°C.

   c. Turn instrument on and set the range switch to give the highest reading possible. Avoid calibrating on one range and making measurements on another range.

   d. The meter should read 1,413 μmhos/cm at 25.0°C. If not, adjust red standardization screw with small screwdriver to obtain proper reading.

   e. Thoroughly rinse probe with distilled water after completing calibration process.

2. Conductivity Meter Operation

   a. Plug probe to connector on back of meter housing.

   b. Immerse conductivity probe in groundwater sample. Dip probe up and down a few times and gently stir to remove air bubbles from tip.

   c. Turn function knob to MICROMHO using range knob, selecting range that gives largest reading possible. (The 2,000 range setting is most commonly used when measuring groundwater samples from Kansas aquifers.)

   d. After meter display stabilizes, record conductivity on field sheet. Round values to nearest 1 μmho/cm if in range 200, nearest 10 μmho/cm if in range 2,000, nearest 100 μmho/cm if in range 20,000, and nearest 1,000 μmho/cm if in range 200,000.

   e. Thoroughly rinse probe in distilled water between samples.

   f. Turn off meter off and unplug probe after use. Allow probe to dry before storage.

3. Conductivity Meter Inspection and Maintenance

a. The conductivity meter must be thoroughly inspected and calibrated at beginning of each field season to ensure proper operation. Proper calibration should be confirmed at weekly intervals throughout field season. If meter is malfunctioning, a backup meter must be used pending repair or replacement of instrument.

b. Routine maintenance may include probe or battery replacement. All maintenance checks are recorded in instrument log book. Replace batteries at least annually. The manufacturer recommends using alkaline batteries.

c. If probe becomes dirty or a crust develops, rinse thoroughly with demineralized water or stir probe in a weak detergent solution. To clean probe of oils, greases, or fats, use a strong detergent solution or dip probe into 1:1 (v/v) mixture of hydrochloric acid and demineralized water, then rinse probe copiously with demineralized water.

d. Record all operational problems, routine maintenance actions, and instrument repairs in instrument log book.

B. Thermometer

The Fisher model #15-0778 stainless-steel dial scale thermometer is an easy to use, portable, manual, direct read instrument. It measures temperature in Celsius ranging from -10 to 110 degrees.

1. Thermometer calibration is accomplished by comparing instrument to an NIST-traceable reference thermometer. If adjustment is required, carefully turn adjusting nut located on back of dial until correction is completed.

2. When measuring temperature of sample, immerse at least a couple of inches of slender probe into sample. Avoid touching probe just prior to and during measurement. Read temperature to nearest one degree by observing indicator on dial. Do not use thermometer to measure substances colder than $-10^{o}C$ or hotter than $110^{o}C$.

3. Procedures for thermometer maintenance include a thorough inspection prior to every field season to ensure instrument is properly calibrated and operating within manufacturer's specifications. If instrument is malfunctioning and/or cannot be calibrated, it must be replaced. If probe becomes dirty or if a crust develops, rinse it thoroughly with demineralized water or a mild detergent solution.

PROCEDURES FOR FIELD ANALYTICAL MEASUREMENTS (GQMP-004)

(NOTE: This procedure, first adopted in 1995, has since been incorporated into GQMP-003. The designation “GQMP-004" has been reserved to avoid the need for renumbering other original SOPs).

PROCEDURES FOR COLLECTING, PRESERVING AND TRANSPORTING GROUNDWATER SAMPLES (GQMP-005)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the proper procedures for the collection, preservation, and transportation of groundwater samples.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the physicochemical properties of groundwater and in the performance of environmental field investigations.

C. Field Equipment and Supply Checklist

See Appendix A.

II. PROCEDURES

A. Safety Requirements and Protocols

1. **Staff must read GQMP-002, Vehicle Safety and Maintenance Procedures, before engaging in groundwater quality sampling or reconnaissance operations. Procedures and requirements indicated in GQMP-002 must be strictly observed by staff.**

2. **Sampling and reconnaissance operations shall not be attempted if severe weather conditions, dangerous travel conditions, or other factors preclude adherence to established sampling or safety protocols or otherwise impose an undue risk to program personnel or other individuals.**

3. **Staff implementing this SOP must maintain current certifications in standard (basic) first aid and cardiopulmonary resuscitation (CPR), as taught by the American Red Cross or equivalent institutions.**

4. **Individuals collecting groundwater quality samples must exercise caution when work surfaces at the well site (platforms, ladders, stairs, cement pads, etc.) are slippery owing to moisture, ice, snow, mud or other causes.**

5. **Sample collectors must exercise caution when working around electricity or electrical devices such as well pumps, water treatment devices, and well-house lighting. Electrical shock could result in serious injury or death. Remember, water is an electrical conductor.**

6. **Sample collectors must exercise caution when sampling in close proximity to chlorine gas or liquid chlorine storage areas. Chlorine is often used as a disinfectant during the drinking water treatment process. Chlorine gas has an odor similar to household bleach and is primarily a respiratory irritant. In sufficient concentration, this gas irritates mucous membranes, the respiratory system, and skin. In extreme cases, difficulty in breathing may increase to the point where death can occur from suffocation. Liquid chlorine in contact with eyes or skin will cause local irritation and/or burns. Contaminated eyes, skin, or clothing should be immediately flushed with copious amounts of running water for at least 15 minutes. Seek medical attention immediately if bodily harm results from exposure to liquid chlorine or chlorine gas. Do not enter any area that has a penetrating odor of chlorine gas.**

7. **Sample collectors must exercise caution when sampling near large diameter wells or pits (such as hand dug wells, etc.). An accidental fall into a well or a flooded pit can result in serious injury or drowning.**

8. **Staff must exercise caution when dealing with domestic or wild animals. Territorial animals may become aggressive, and startled livestock may stampede. Bites or scratches from any animal may transmit disease and should receive appropriate medical attention.**

9. **Staff shall avoid handling containers with acids or other reagents when sampling vehicle is in motion. Staff shall wear safety goggles and disposable polyethylene gloves (or other suitable hand and eye protection) when preserving samples with acids or other chemical reagents or when handling samples that are obviously contaminated with sewage or industrial effluent, livestock waste, or other potentially hazardous or infective materials. If acid splashes into eyes, immediately use emergency eyewash station or spray a stream of demineralized water onto affected area. Continue flushing until supply of demineralized water is depleted, then seek medical assistance.**

10. **Staff shall utilize provided hearing protection when working in excessively noisy environments, such as in immediate proximity of internal combustion engines used to pump groundwater from many irrigation wells. Exhaust mufflers on these engines are often inadequate or nonexistent.**

11. **Field equipment and supplies, including ice chests, sample containers and containers bearing acids or other chemical reagents, shall be safely stored and secured during transport. Plastic bottles containing acids or other chemical reagents shall be capped and placed in covered plastic storage container when not in use.**

B. Site Verification

1. Verify well location by referring to file maps and photographs. Visually inspect number on site identification (SID) tag as a final confirmation. Record in field notes any noticeable change in condition of well or pumping equipment since last visit.

2. All network wells are required to possess an official State of Kansas SID metal tag with a unique number stamped on it. If a new well is added to network, or if an old SID tag is missing or destroyed, a new SID tag must be secured in a visible location on or near the well, pump, or associated apparatus. If a new SID tag is installed, the accompanying SID form must be completed in full and submitted to the Office of Information Systems as soon as possible.

C. Well Purging and Other Preliminary Actions

1. Turn on well pump. Confirm pump is functioning properly. Open sampling valve and flush sampling outlet to remove stagnant water from well and valve. At one- to five-minute intervals, partially fill stainless steel pail with groundwater from outlet and immediately measure water temperature, pH and conductivity (see GQMP-003). Continue flushing pump and outlet until at least five well volumes are removed and successive measurements for temperature, pH and conductivity differ by no more than 1^{o}C, 0.1 pH unit, and 5%, respectively. The amount of time required to do this varies with well diameter, depth to groundwater, pumping rate, and other well and aquifer features. For most high-volume well pumps, 15-20 minutes of flushing is usually needed to obtain samples representative of underlying aquifer.

2. Raw (untreated) groundwater samples are collected as close as possible to the wellhead (check site file for sample point location). Chlorinator pumps and/or other water treatment devices must be turned off or unplugged from

power source if injection lines enter the distribution system between wellhead and sampling outlet.

C. Sample Container Preparation and General Sample Collection Procedures

1. Prior to sample collection, record sample container numbers on field sheet. Label sample containers with site name and number, date, and collector's initials.

2. Collect groundwater samples in appropriate containers (see below) from water exiting sampling outlet. Fill containers without touching them to sampling outlet or other objects. Do not allow foreign matter to enter sample containers. Take care not to touch or otherwise contaminate rim or inside of sampling container or lid. If this does occur, repeat above steps with fresh container and/or lid.

3. In those rare situations where sampling containers cannot be filled directly from sampling outlet, collect sample in stainless-steel pail after rinsing pail at least three times with sample water. Fill sample containers by pouring water from pail into containers, avoiding any direct contact between pail and containers. Record any unusual sampling problems or deviations from established sampling procedures on field data sheet.

D. Detailed Sample Collection and Preservation Procedures

1. Inorganic Chemistry Sample

   a. Inflate new, one-quart (one-liter) plastic cubetainer by mouth. Collect inorganic sample in cubetainer by placing under stream of water exiting sampling valve. Fill cubetainer completely, then seal opening of cubetainer with plastic cap, tightening cap securely.

   b. Place sealed cubetainer on ice in sample cooler for transport to KHEL inorganic chemistry laboratory.

2. Nutrient Sample

   a. Collect nutrient sample in a 175-ml Nalgene plastic bottle (marked “NUT”). Avoid overfilling, as bottle has been pre-acidified with sulfuric acid solution. Leave a 3-4 cm space at top of bottle to accommodate mixing. Replace cap and tighten securely.

   b. Gently shake sealed bottle for approximately 10 seconds to ensure thorough mixing of sample and acid preservative. Place sealed sample bottle on ice in sample cooler for transport to KHEL inorganic chemistry laboratory.

3. Heavy Metal Sample

   a. Collect heavy metal sample in 250-ml Nalgene plastic bottle (marked “HM”). Avoid overfilling, as bottle has been pre-acidified with nitric acid solution. Leave a 3-4 cm space at top of bottle to accommodate mixing. Replace cap and tighten securely.

   b. Gently shake sealed bottle for approximately 10 seconds to ensure thorough mixing of sample and acid preservative. Place sealed sample bottle on ice in sample cooler for transport to KHEL inorganic chemistry laboratory.

4. Pesticide Sample

   a. Collect pesticide sample in acetone-rinsed, one-gallon (four-liter) amber glass jug, filling jug to bottom of neck. Replace Teflon-lined plastic cap, tightening securely.

   b. Store sealed sample jug on ice in sample cooler for transport to KHEL organic chemistry laboratory.

5. Volatile Organic Compound (VOC) Sample

   a. Collect VOC sample in 40-ml clear glass vial, allowing bead of water to rise above opening of vial. Float Teflon-lined septum (cap liner) on top of meniscus, ensuring that Teflon side (thin white side) faces water. Replace plastic cap on vial, tightening securely.

   b. Turn vial upside down, tap lightly, and inspect closely for any air bubbles. If bubbles are present, select another, clean vial, repeat step (a), above, and recheck for bubbles. Continue this process until a sample without bubbles is obtained.

   c. Store sealed vial on ice in sample cooler for transport to KHEL organic chemistry laboratory.

6. Radionuclide Sample

   a. Collect radionuclide sample in one-gallon (four-liter) plastic jug. Avoid overfilling, as jug has been pre-acidified with nitric acid solution. Leave a 3-4 cm space at top of jug to accommodate mixing. Replace cap and tighten securely.

b. Gently shake sealed jug for approximately 10 seconds to ensure thorough mixing of sample and acid preservative. Place sealed sample jug in a secure location in vehicle for transport to KHEL radiation chemistry laboratory. (Storage of sample on ice is not necessary.)

c. Collect additional water sample in 40-ml plastic vial accompanying plastic jug. Replace plastic cap, tighten securely, and wedge sample vial inside handle of radionuclide jug for transport to KHEL radiation chemistry laboratory. (The 40-ml sample is used by laboratory for measurement of specific conductance which determines aliquot volume for gross alpha analysis.)

7. Radon Sample

a. The radon sampling kit obtained from the radiation chemistry laboratory includes one sampling funnel with tube and faucet adapter, one cardboard sample box, one plastic syringe with hypodermic needle, and four glass scintillation vials each with polyseal caps and containing 10 ml of mineral oil-based liquid scintillation solution. Three vials are labeled 1, 2, or 3, and the fourth is used as a backup. The backup vial is reserved in case one of the other vials becomes broken or contaminated.

b. Attach sampling funnel and tube to sampling outlet faucet with adapter. Slowly turn on water and allow a steady stream to flow out of funnel for approximately two minutes.

c. Reduce water flow to a level (usually just a trickle) that does not cause turbulence in pool of water contained in funnel. Allow excess water to spill over one edge of funnel. Examine hose connection and tubing for air bubbles or pockets. If any are visible, raise or lower funnel until they are removed.

d. Place tip of hypodermic needle approximately 3 cm under surface of water in funnel. Withdraw a few milliliters of water and discard. Repeat this procedure two more times for a total of three rinses.

e. Again, place tip of needle about 3 cm below water surface and withdraw slightly more than 10 ml. Pull water into syringe slowly to avoid extreme turbulence and collection of air bubbles. If large air bubbles are noticed in syringe, discard sample and redraw another.

f. Invert syringe and slowly eject any small air bubbles and extra water, retaining precisely 10 ml of water in syringe.

g. Remove cap from a sample vial and carefully place tip of needle into bottom of liquid scintillation solution. Slowly eject sample from syringe into vial. **Inject sample underneath surface of liquid scintillation solution to prevent loss of radon from sample.** If water is forced out with too much pressure, it will cause turbulence and may result in loss of radon.

h. Carefully withdraw hypodermic needle from vial and replace cap securely to prevent leakage.

i. Repeat steps e through i to obtain two more samples for a total of three samples from the same source. Complete the appropriate Laboratory Submission form. Put sample vials, backup vial, syringe, and needle back into sample box.

j. Store sample box in secure location in van for return to KHEL radiation chemistry laboratory.

CHAIN-OF-CUSTODY PROCEDURES FOR GROUNDWATER SAMPLES AND FIELD-PREPARED QUALITY CONTROL SAMPLES (GQMP-006)

I. INTRODUCTION

A. Purpose

Data derived from the groundwater quality monitoring program may be used in agency enforcement actions or in other regulatory endeavors. Field staff involved in sample collection must ensure that water quality samples are maintained in a secure and appropriate setting and that the transfer of samples to appropriate laboratory personnel, and any intermediaries, is accurately and permanently documented. The following paragraphs describe procedures used in the groundwater quality monitoring program for relinquishing and receiving water quality samples and for ensuring their security and integrity from the moment of collection to the time of transfer to laboratory personnel.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the physicochemical properties of groundwater and in the performance of environmental field investigations.

II. PROCEDURES

A. All samples submitted to KHEL for analysis must be accompanied by an appropriate sample submission form (Appendix C). This includes water quality samples for minerals, nutrients, heavy metals, pesticides, radionuclides, radon, and any special samples analyzed by KHEL.

B. At the bottom of each sample submission form are fields for chain-of-custody. The first field is signed by the BEFS employee (usually the program manager) that collected the samples in question. On the date the samples are delivered to KHEL, this person must sign/date the first chain-of-custody field using indelible ink. Upon delivery, staff of KHEL will accept the samples and sign/date the second chain-of-custody field, again using indelible ink. This provides a record of custody from the time of collection to the time of arrival at KHEL.

C. Photocopies of sample submission forms are made at the laboratory immediately after signatures are obtained. The original forms are retained by the program manager for filing in groundwater quality monitoring program file. Photocopies are retained by the laboratory employee receiving the samples.

D. In the unlikely event samples are transferred to an intermediate party en route to the laboratory, additional chain-of-custody fields are filled out on the sample submission forms. The KHEL forms supply three sets of fields on each form. Each time a person accepts or relinquishes responsibility for the samples, he/she must fill out a chain-of-custody field on each separate submission form.

E. Forms completed in the field contain important empirical data and supporting documentation. Loss of these forms, or any accident which would impair their legibility, would result in a significant loss of data and could necessitate a return trip to the groundwater well in question. Hence, it is imperative that care be taken by staff in the handling, filing and eventual archiving of these documents. Similar considerations apply to any photographs or other forms of documentation obtained during the course of field activities.

PROCEDURES FOR FIELD BLANK SAMPLES (GQMP-007)

I. INTRODUCTION

A. Purpose

Unless closely monitored and controlled, the inadvertent contamination of samples during collection, preservation, transport, storage, processing and/or analysis may lead to erroneous conclusions about the quality of the environment. Field blanks provide one means of assessing and quantifying the overall extent of sample contamination. The following paragraphs set forth those procedures for preparing field blanks utilized in the groundwater quality monitoring program.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the physicochemical properties of groundwater and in the performance of environmental field investigations.

C. Equipment/Accessories

1. All items listed in Appendix A
2. Plastic jug (1 gal) filled ASTM Type-I quality water
3. Dark glass jug (1 gal) filled with ASTM Type-I quality water

II. PROCEDURES

A. Preparation of Field Blanks

1. Prior to sampling run, fill 3.8-liter (one-gallon) plastic container and a 3.8-liter dark glass jug with ASTM Type-I quality demineralized water, available at KDHE inorganic laboratory. Replace and securely tighten plastic cap on plastic container and Teflon-lined plastic cap on glass jug. Transport containers in sampling vehicle to selected groundwater quality monitoring location.

2. Upon arrival, and following completion of regular sampling and field measurement activities (GQMP-004 and -005), fill cubetainer and a 100-ml glass beaker with demineralized water by pouring directly from one-gallon plastic container. Seal container with plastic lid, tightening securely, and store in ice chest with regular inorganic samples. Perform temperature, pH

and conductivity measurements on water in beaker (GQMP-004), and record readings in field notes.

3. Fill empty pesticide sampling jug with demineralized water from jug containing demineralized water. Seal former jug with Teflon-lined plastic lid, tightening lid securely. Store jug in ice chest with regular pesticide samples.

B. Field Blank Laboratory Identification Codes and Related Considerations

1. Assign all blank samples a laboratory identification code of SG000 on sample submission forms and field notes. Record field blank "collection" time, equaling that of previous regular sample plus five minutes, on sample submission forms and in field notes. (This five-minute time separation will be used, along with identification code, to designate sample as a field blank in Kansas Water Database).

PROCEDURES FOR FIELD DUPLICATE AND REPLICATE SAMPLES (GQMP-008)

I. INTRODUCTION

A. Purpose

Field duplicate and replicate samples provide a combined measure of natural sample variability and the variability inherent in sampling and analytical efforts. They allow estimates of data precision to be obtained and incorporated into statistical measures of groundwater quality. The following text outlines those procedures used in the groundwater quality monitoring program for the collection and handling of duplicate and replicate groundwater samples.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the physicochemical properties of groundwater and in the performance of environmental field investigations.

C. Equipment/Accessories

See Appendix A.

II. PROCEDURES

1. Follow procedures described in SOP No. GQMP-005 for collection and preservation of water samples and performance of preliminary field measurements.

2. Before leaving groundwater quality monitoring site, generate another (duplicate) set of samples/measurements by repeating all above procedures.

3. If additional (replicate) sets of samples/measurements are desired, repeat the above procedures as many times as needed.

4. Record a five-minute time differential between successive sets of samples/measurements. This time interval will designate the samples as duplicate or replicate samples in the Kansas Water Database.

PROCEDURES FOR FIELD SPIKED SAMPLES (GQMP-009)

I. INTRODUCTION

A. Purpose

The following paragraphs describe those procedures used in the groundwater quality monitoring program for field spiking samples with known concentrations of selected chemical parameters. Measured levels of these parameters in spiked samples are compared to those in unamended duplicate samples to provide an overall indication of sample degradation and analytical recovery. Field spikes provide one means of quantifying the accuracy of water quality data.

B Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the physicochemical properties of groundwater and in the performance of environmental field investigations.

C. Equipment/Accessories

1. All items listed in Appendix A
2. Stainless-steel pail, 11.4 liter (3 gal)
3. Stainless-steel funnel
4. Trace metal/metalloid reference solution
5. Cation reference solution
6. Anion reference solution
7. Nutrient-1 reference solution
8. Nutrient-2 reference solution
9. Pesticide reference solution
10. Graduated cylinder, 1-liter, glass, with enlarged plastic stopper
11. Graduated cylinder, 2-liter, glass, with enlarged plastic stopper (2)
12. Brinkmann Eppendorf pipette, fixed volume, 1000 μL
13. Brinkmann Eppendorf pipette, adjustable volume, 100-1000 μL
14. Brinkmann Eppendorf pipette tips
15. Pasteur pipette, disposable borosilicate glass, 5-3/4"
16. Plastic jug, one-gallon, filled with ASTM Type-I quality water

II. PROCEDURES

A. Overview of Field Spike Procedures

Follow procedures in SOP No. GQMP-005 for collection and preservation of groundwater samples, with following modifications.

1. Rinse three-gallon stainless-steel pail three times with water from sampling outlet, then fill pail with water from outlet. Transport pail with sample to field vehicle. Immediately fill sampling containers and graduated cylinders needed for pesticide sample fraction (see below). Swirl pail gently before pouring to minimize settling of any suspended materials.

2. Return to well and refill pail with water from sampling outlet. Transport pail with sample to field vehicle. Immediately fill sampling containers and graduated cylinders needed for inorganic chemistry and trace (heavy) metal sample fractions (see below). Swirl pail gently before each pour to minimize settling of suspended materials.

3. The laboratory identification code for all field-spiked fractions is recorded as SG999. Time of collection for all field-spiked fractions is recorded as five minutes after collection of regular sample. The code and five-minute time differential are used to signify a field-spiked sample in the Kansas Water Database .

B. Specific Field Spike Procedures

1. Pesticide (Organic) Spike

   a. Rinse a two-liter graduated cylinder with sample water by pouring water from three-gallon stainless-steel pail through stainless-steel funnel. Discard rinse water and refill two-liter cylinder to 2000-ml mark (read bottom of meniscus formed when sample water wets cylinder wall). Transfer contents into a one-gallon dark glass jug using funnel. Refill two-liter cylinder to 2000-ml mark, reading meniscus.

   b. Use funnel and remaining water in sampling pail to completely fill another one-gallon dark glass jug. Replace cap and tighten securely. This jug contains unamended pesticide sample.

   c. Invert pesticide ampule several times to mix. Open ampule by carefully snapping at score line. Transfer contents (certified reference solution, 1-ml) into jug containing 2000 ml of sample water. Using a Pasteur pipette, rinse ampule three times with sample water from two-liter cylinder, transferring each rinse to jug. Pour remaining water in two-liter cylinder into jug using funnel. Replace Teflon-lined plastic cap on jug and tighten securely. Mix contents of jug by inverting several times. This jug contains amended (spiked) pesticide sample.

d. Rinse two-liter cylinder three times with demineralized water, discard rinse water, and store cylinder with other supplies for transport. Pack amended and unamended pesticide sample containers in chipped ice inside ice chest pending delivery to KDHE organic laboratory.

2. Combined Trace Metal and Cation Spike

a. Rinse one-liter graduated cylinder by pouring water into cylinder from three-gallon stainless-steel pail through stainless-steel funnel. Discard rinse water. Pour a predetermined volume of sample water into rinsed, one-liter cylinder using funnel. (Note: This volume is calculated prior to sampling run by program manager and unit chief based on targeted spike amendment, which varies from one field outing to another.)

b. Pour remaining sample water from sampling pail directly into heavy metal bottle. This bottle contains unamended heavy metal/cation sample.

c. Invert ampule marked “trace metals” several times to mix. Unscrew cap from ampule and transfer predetermined amount of ampule contents (trace metal reference solution) into one-liter cylinder using adjustable Eppendorf pipette.

d. Invert ampule marked “cations” several times to mix. Unscrew cap from ampule and transfer predetermined amount of ampule contents (cation reference solution) into one-liter cylinder using adjustable Eppendorf pipette.

e. Cap cylinder with plastic stopper and invert ten times to mix. Transfer contents of cylinder into heavy metal sample bottle. This bottle contains amended (spiked) heavy metal/cation sample. Gently shake both heavy metal bottles approximately ten seconds to ensure thorough mixing of sample and preservative. Place bottles in wooden flat and store in secure area of sampling vehicle pending delivery to KHEL organic chemistry laboratory.

f. Rinse one-liter cylinder three times with demineralized water, discard rinse water, and store cylinder with other supplies for transport.

3. Nutrient and Anion Spikes

a. Rinse two-liter graduated cylinder by pouring water into cylinder from three-gallon stainless-steel pail through stainless-steel funnel. Discard rinse water. Pour a predetermined volume of sample water into two-liter cylinder using funnel.

b. Apportion remaining sample water among mineral container (one-quart cubetainer) and nutrient bottle, pouring directly from pail through funnel. Cubetainer and bottle contain unamended mineral sample and unamended nutrient sample, respectively. Replace cubetainer and bottle lids, and tighten securely. Gently shake nutrient bottle for about 10 seconds to ensure complete mixing of sample and acid preservative.

c. Invert ampule marked “anions” several times to mix. Unscrew cap from ampule and transfer predetermined amount of contents (anion reference solution) into two-liter cylinder using adjustable Eppendorf pipette.

d. Invert ampule marked “nutrient-1" several times to mix. Unscrew cap from ampule and transfer predetermined amount of contents (anion reference solution) into two-liter cylinder using adjustable Eppendorf pipette. (Note: This same cylinder is referenced in steps a and c, above.) Cap cylinder with plastic stopper and invert ten times to mix contents.

e. Apportion contents of cylinder among mineral cubetainer and nutrient bottle. Cubetainer and bottle contain amended mineral sample and amended nutrient sample, respectively. Replace cubetainer and bottle lids, and tighten securely. Gently shake nutrient bottle for about 10 seconds to ensure complete mixing of sample and acid preservative.

g. Rinse both two-liter graduated cylinders three times with demineralized water, discard rinse water, and store cylinders with other supplies for transport. Pack all mineral sample cubetainers and nutrient sample bottles in chipped ice inside ice chest. Store ice chest in secure location in sampling vehicle pending transport to KHEL inorganic chemistry laboratory.

APPENDIX C

STANDARDIZED FIELD SHEETS, SAMPLE SUBMISSION FORMS, AND WELL TAGS

TABLE OF CONTENTS

FORM APP.C-1

LABORATORY SAMPLE SUBMISSION FORM WITH CHAIN-OF-CUSTODY BLOCK

Kansas Department of Health and Environment
Division of Health and Environmental Laboratories
Forbes Field, Building 740
Topeka, Kansas 66620-0001

Lab Number: ________
Date Received: ________
Analysis Code: ________

Sample Submission Form

Report To: ____________________ **Address:** ____________________

Collection Site: ____________________
Legal Project Code Name PWS Acct. No.

Site ID Number: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ **Collection Depth:** __ __ __ __ Feet

Sample Type: Water Soil Sediment Sludge Air Oil Solid Liquid Wipe **Priority:** Regular Moderate Urgent

Sample Collector: ____________________ Name Agency (Abbr) **Date:** __ – __ – __ Mo Day Yr **Time:** __ __ __ __ 24 Hour

Program Code: EA EB EC ED EE EF EG EJ EL EP ER ET EW ES FK LM SC SE SG SN SP SW PC
PD PE PG PI PL PP PT PU PV WE WI HD HF HL HS RP AR GS KC US AQ RT WC

Organic Chemistry Laboratory

Check Desired Analysis: ☐ Other ____________________ VOC Sample Acidified: ☐

☐ Volatiles Method: ☐ 624 ☐ 8260 ☐ 524.2 ☐ Pesticides Method: ☐ 608 ☐ 8080 ☐ 507/8

☐ Acids Method: ☐ 625 ☐ 8270 ☐ Base/Neutrals Method: ☐ 625 ☐ 8270 ☐ 525.2

☐ PCB's Method: ☐ 608 ☐ 8080 ☐ Oil ☐ Herbicides Method: ☐ 615 ☐ 8150 ☐ 515.1

Inorganic Chemistry Laboratory

Bottle Nos.: Chem ______ DO ______ NUT ______ HM ______ CN ______ O&G ______ Phenol ______

Check Desired Analysis: ☐ Other ____________________

☐ Metals ☐ Mercury ☐ Mineral ☐ TCLP

Radiation Chemistry Laboratory

Check Desired Analysis: ☐ Other ____________________

☐ Gross Alpha ☐ Gross Uranium ☐ Ra-226 ☐ Ra-228

Sample Comments: ____________________

Chain of Custody:

Date ________ Relinquished By ____________ Received By ____________

Date ________ Relinquished By ____________ Received By ____________

Date ________ Relinquished By ____________ Received By ____________

Additional Reports Routed To:

Name ____________ Address ____________

Name ____________ Address ____________

Name ____________ Address ____________

DHEL-09/99

Instructions for this form are printed on the reverse side

FORM APP.C-2

GROUNDWATER QUALITY MONITORING PROGRAM FIELD NOTES

KANSAS GROUNDWATER MONITORING NETWORK FIELD NOTES

DATE: ____________ TIME: ____________ COLLECTOR: ______________

SITE NAME: ____

SITE I.D. NUMBER: ____

SITE LOCATION: ____

COUNTY: ________________________ PWS ACCOUNT #: _________________

STATUS OF S.I.D. TAG: Okay [ ] Missing [ ] Other __________

SAMPLES COLLECTED: Cubitainer [ ] [ ] HM [ ] [ ] Nut [ ] [ ]

Radon [ ] [ ] Pesticide [ ] [ ] VOC [ ] [ ] Rad [ ] [ ]

TEMP: ____________ pH: ___________ CONDUCTIVITY: ____________

TEMP: ____________ pH: ___________ CONDUCTIVITY: ____________

CONTACTED OR ACCOMPANIED BY: ______________________________________

____

ADDITIONAL NOTES OR COMMENTS: _____________________________________

____

____

____

FORM APP.C-3

GROUNDWATER NETWORK WELL (SITE) IDENTIFICATION FORM

Amended Report ☐

State of Kansas
Site I.D. Form

a. County: b. Site I.D. number: 00017749

c. Owner Name:

d. Owner Address: City State Zip Code

e. This site is located at (66 characters max.)

f. Encoded Owner Name: ☐☐☐☐☐☐☐☐☐☐☐ g. Well (site) Number: ☐☐☐

h. Encoding Scheme (Circle only one number):

1. If city owned, enter the first 11 letters of the city name (leave a blank space between words if more than one word is used).
2. If County owned, enter the first 11 letters of the county name ("Pottawatomi," for Pottawatomie) or abbreviate when it is necessary to show the type of site ("AL San Lndf," for Allen County Sanitary Landfill).
3. If business owned, write the first 11 letters of the business name (include RWDs, e.g., SN RWD1, for Shawnee Co. RWD 1).
4. If owned by an individual, enter the first 8 letters of the last name, a comma, and the first 2 letters of the first name.
5. If none of the above apply, encode the owner name in the most meaningful manner possible and explain procedure in Item y.

i. This well (site) is in Sec. _____, Twn. _____, Rng. _____ (circle one) E / W. From the (circle one) NE / SW / SE / NW corner of this section, this site is _________ ft (circle one) N / S and _________ ft (circle one) E / W, and is in the _______1/4 of the _______1/4 of the _______1/4 of the _______1/4.

j. Measurement Method Used (circle only one number):

1. Legal Survey	2. Absolute Survey	3. GPS Survey	4. Technical Survey	5. Compass & Chain
6. Hand Wheel	7. USGS 7.5' Topomap	8. County Road Map	9. Other:	

k. Measured By: ______________________ (last name), _____ (first init.) of (kk.) __________ (abbreviate) (Agency), __________ (abbreviate) (Bureau).

l. The tag is attached to the , (ll.) using .

m. Water Source (circle only one number):

1. Well	2. Spring	3. Pit	4. Lake / Pond	5. Stream / River
6. Ditch / Canal	7. Storm Runoff	8. Treated Water (Distribution System)		9. Waste water

n. Use(s) of Water (circle all that apply):

1. Domestic	2. Irrigation	3. Feedlot	4. Industrial	5. Public Water Supply
6. Oil Field Water Supply	7. Lawn and Garden Only	8. Air Conditioning	9. Dewatering	10. Monitoring Well Only
11. Injection Well	12. Artificial Recharge	13. Recreation	14. Other (Specify):	

o. Type of Casing (circle only one number):

1. Steel	2. PVC	3. RMP (SR)	4. ABS	5. Wrought Iron
6. Asbestos Cement	7. Fiberglass	8. Concrete Tile	9. Other (specify or write "UNK" if unknown): ______________	

p. Form Completed By: ______________________ (last name), _____ (first init.) of (pp.) __________ (abbreviate) (Agency), __________ (abbreviate) (Bureau).

q. Your Work Phone Number: (_____ area code) - ______ prefix - ____________ number qq. Date: ______ mm - ______ dd - ______ yy

r. Program Code:

EP ER EE EU EL ET EJ SC SG SN SW SE SP FK LM ES AR KC
PU PC PT PE PD PV PI WI WE PP HL HD HF HS WC RP GS US

s. Project Code: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

t. Optional "well number codes": Consultant Code ___ , and / or (S)hallow, (I)ntermediate, or (D)eep ___ .

u. Well Depth (TOC to TD):_____ . ___ ft. v. TOC is ____ . ___ ft. above/below ground elevation. w. TOC Elevation: ____ . ___ft.

x. DWR File Number: xx. Is this a replacement well (circle one)? Yes / No

y. Comments:

REV JAN 92

TAG APP.C-1

GROUNDWATER NETWORK WELL (SITE) IDENTIFICATION TAG

APPENDIX D

GLOSSARY OF TERMS

GLOSSARY OF TERMS

accuracy -- the extent to which a measured value actually represents the condition being measured. Accuracy is influenced by the degree of random error (precision) and systematic error (bias) inherent in the measurement operation (e.g., environmental sampling and analytical operations).

activity -- an all inclusive term describing a specific set of operations or related tasks to be performed, either serially or in parallel (e.g., research and development, field sampling, analytical operations), that in total result in a product or service.

aquifer -- a geological formation, group of formations, or part of a formation capable of yielding a significant amount of water to a well or a spring.

assessment -- the evaluation process used to measure the performance or effectiveness of a system and its elements. As used in this program QA management plan, "assessment" is an all-inclusive term used to denote audits, performance evaluations, management system reviews, internal reviews and related actions.

audit -- a systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

bias -- the systematic or persistent distortion of a measurement process which causes errors in one direction (i.e., the degree to which the expected sample measurement is different from the true sample value).

calibration -- a comparison of a measurement standard, instrument, or item with a standard, instrument or item of higher accuracy to detect, quantify and report inaccuracies and to eliminate these inaccuracies through adjustments.

chain of custody -- an unbroken trail of accountability that ensures the physical security of samples, data and records.

comparability -- a measure of the confidence with which one item (e.g., data set) can be compared to another.

completeness -- a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

computer program -- a sequence of instructions suitable for processing by a computer. Processing may include the use of an assembler, compiler, interpreter, or translator to prepare the program for execution. A computer program may be stored on electrical, magnetic or optical media.

corrective action -- any measure taken to rectify a condition adverse to quality and, if possible, to preclude its recurrence.

data performance criteria -- qualitative and quantitative statements that define the appropriate type of data and/or specify tolerable levels of potential decision errors used as the basis for establishing the quality and quantity of data needed to support decisions.

data quality assessment -- a scientific and statistical evaluation of a set of environmental data to determine the adequacy of the data for its intended use.

deficiency -- an unauthorized deviation from acceptable procedures or practices.

detection limit -- the lowest concentration of a target analyte that a given method or instrument can reliably ascertain and report as greater than zero.

document -- any written or pictorial information describing, defining, specifying, reporting or certifying activities, requirements, procedures or results.

duplicate samples -- paired samples collected at essentially the same time from the same site and carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitoring instrument, and/or analyst. More than two such samples are referred to as replicate samples.

environmental data -- the description of a physical medium (e.g., air, water, soil, sediment) or biological system expressed in terms of some measurable physical, chemical, radiological or biological characteristic or set of characteristics.

environmental monitoring program -- a planned and systematic operation for characterizing an environmental process or condition. For the purposes of this program QA, the term “program” refers to a major, ongoing or longer term environmental monitoring operation.

environmental monitoring project -- a planned and systematic operation for characterizing an environmental process or condition. For the purposes of this program QA management plan, the term “project” refers to a smaller scale or shorter term environmental monitoring operation.

field blank -- a clean sample (e.g., distilled water) that is otherwise treated the same as other samples collected in the field. Field blanks are submitted to the analyst along with other samples and are used to detect any contaminants that may be introduced during sample collection, storage, analysis and transport.

field spike -- a spiked sample prepared in the field. See spiked sample.

groundwater -- water located under the surface of the land that is or can be a source of supply for wells, springs or seeps, or that is held in aquifers or the soil profile (K.A.R. 28-16-28b(bb)). For the purposes of this QA management plan, the term is restricted in usage to water contained in aquifers or directly yielded from an aquifer via a well.

holding time – an agreed upon, maximum interval of time in which a sample can be held under prescribed preservation methods.

independent assessment -- a quality assessment of an environmental monitoring program, project or system performed by a qualified individual, group, or organization that is not part of the program, project or system.

inspection -- examination or measurement of an activity to verify conformance with specific requirements.

internal assessment -- any quality assessment of the work performed by an individual, group, or organization, conducted by those overseeing and/or performing the work.

method -- a body of procedures for performing an activity in a systematic and repeatable manner.

nonparametric statistics -- procedures for organizing and interpreting numerical data that are free of any assumptions about the data distribution and do not require estimation of the variance, mean or other population parameters.

parametric statistics -- procedures for organizing and interpreting numerical data that employ certain assumptions about the data distribution and require estimation of at least one population parameter.

peer review -- a critical review of a finding or document conducted by qualified individuals other than those who produced the finding or document but collectively equivalent in technical expertise.

performance evaluation -- a type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of a technician, analyst or laboratory.

precision -- the level of agreement among individual measurements of the same property, conducted under identical or similar conditions.

qualified data -- data that have been modified, adjusted or flagged in a data base following data validation and verification procedures.

quality -- those features of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user.

quality assurance (QA) -- an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item or service is of the type and quality needed and expected by the user.

quality control (QC) -- the overall system of technical activities that measures the attributes and performance of a process, item or service against defined standards to verify that they meet the stated requirements of the user.

quality management plan (QMP) – a formal document that describes a quality management system in terms of the organizational structure, functional responsibilities, and planning, implementation and assessment of work.

record – a document or portion thereof furnishing evidence of the quality of an item or activity, verified and authenticated as technically complete and correct. Records may include reports, photographs, drawings, and data stored on electronic, magnetic, optical or other recording media.

replicate sample -- see duplicate sample.

reporting limit -- the lowest (or highest) concentration (or level) of a parameter that can be reliably reported by an individual analyst or laboratory based on the applied analytical method and instrumentation, the ability of the analyst or laboratory, and the effort devoted to the analytical determination.

representativeness -- a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system.

reproducibility -- a measure of the degree to which sequential or repeated measurements of the same system vary from one another, independently of any actual change in the system.

sensitivity -- a measure of the capacity of an analytical method or instrument to discriminate between different levels of a variable of interest.

spiked sample -- a sample of water, air, soil, sediment, biological tissue or other material which is amended by the addition of a known amount of a given chemical element or compound. The measured concentration of the element or compound in the amended material is compared to the measured amount in the unamended material to provide a measure of analytical recovery and accuracy.

standard operating procedure (SOP) -- a written, formally approved document that comprehensively and sequentially describes the methods employed in a routine operation, analysis or action.

technical review -- a critical review of an operation by independent reviewers collectively equivalent in technical expertise to those performing the operation.

validation – the establishment of a conclusion based on detailed evidence or by demonstration. This term is often used in conjunction with formal legal or official actions.

APPENDIX E

REFERENCES

REFERENCES

American Public Health Association. 1992. Standard methods for the examination of water and wastewater (18th edition). American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D.C.

Bailey, P.E. and W. D. Ward. 1990. Understanding ground-water contamination: an orientation manual. Executive Enterprises Publications Co., Inc., New York.

Cole-Parmer Instrument Company. Instruction manual for pH meter models 5996-50, 5996-60, 5996-70 and 5996-80.

Fisher Scientific Company. Instruction manual for digital conductivity meter.

Kansas Department of Administration. 1999. Fuelman program overview. Central Motor Pool, Topeka, Kansas.

Kansas Department of Administration. 2000. Vehicle operation overview. Central Motor Pool, Topeka, Kansas.

Kansas Department of Health and Environment. 1982-1995. Radiochemistry procedures manual. Radiochemistry Laboratory, Division of Health and Environmental Laboratories, Topeka, Kansas.

Kansas Department of Health and Environment. 2000. Ashtech Reliance (Submeter) GPS system guide and the Lotus Notes GPS application for all programs. Office of Information Systems, Geographic Information Systems Unit, Topeka, Kansas.

Spruill, T.B. 1983. Statistical summaries of selected chemical constituents in Kansas ground-water supplies, 1976-81. U.S. Geological Survey Open-File Report 83-263.

Spruill, T.B. 1990. Monitoring regional ground-water quality--statistical considerations and description of a monitoring network in Kansas. U.S. Geological Survey Water-Resources Investigations Report 90-4159.

U.S. Environmental Protection Agency. 1980. Prescribed procedures for measurement of radioactivity in drinking water. EPA 600/4-80-032.

U.S. Environmental Protection Agency. 1982. Methods for organic chemical analysis of municipal and industrial wastewater. EPA 600/4-82-057.

U.S. Environmental Protection Agency. 1983. Methods for chemical analysis of water and waste. EPA 600/4-79-020.

U.S. Environmental Protection Agency. 1985. Practical guide for ground-water sampling. EPA 600/2-85/104.

Vitale, R.J., O. Braids and R. Schuller. 1991. Ground-water sample analysis. *In* Nielsen, D.M., [ed.], Practical handbook of ground-water monitoring. Lewis Publishers, Inc.

Wood, W.W. 1976. Guidelines for collection and field analysis of ground-water samples for selected unstable constituents. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 1, Chapter D2.